USING INQUIRY TO BREAK THE LANGUAGE BARRIER

English language learners and science fairs

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The more than five million English language learners (ELLs) in the United States represent over 10% of students enrolled in public schools—and this number is growing rapidly. From 1997 to 2007, growth of ELL enrollment exceeded that of overall enrollment by more than six to one (NCELA 2010).

Regardless of where they teach, science educators will undoubtedly encounter ELL students in their classrooms and be expected to effectively teach science content to these students. The National Science Education Standards (NRC 1996) advocate for the use of inquiry in science teaching for all. But is this possible if students aren't fluent in English?

Although teachers sometimes assume that limited English language skills make ELLs incapable of engaging in scientific inquiry, growing evidence supports the idea that a "synergistic relationship [exists] between science inquiry and language development" (Stoddart et al. 2002, p. 664), and that English proficiency is *not necessarily* a prerequisite for engaging in content learning. In fact, using inquiry with ELLs has been shown to not only enhance scientific thinking but also to facilitate English language acquisition and reasoning ability (Rosebery, Warren, and Conant 1992).

One way for ELL students to engage in inquiry is through a school science fair project or other independent

research endeavor. Though the traditional science fair may not be successful, science teachers can make simple modifications to help ELLs achieve the dual goals of mastering science content and enhancing English language acquisition.

Modifying a project

In my school, a self-contained class of ELLs completed a whole-group science fair project on the variables that affect the period of a swinging pendulum—the time it takes the pendulum to complete one back-and-forth cycle. We tested multiple variables, working through the project in several phases over several weeks. This allowed me to systematically transfer responsibility to students in a way that supported their language needs and was culturally sensitive.

In Phase One, which took one week to complete, I introduced pendulums and asked students to suggest variables that might affect a pendulum's period. I provided the investigation topic and research question rather than having students generate their own: Asking questions is encouraged for deeper understanding in American culture, but this practice isn't necessarily common (or acceptable) in others (Sutherland and Dennick 2002). But students suggested variables based on their own interests. This way, students still had ownership of the investigation question, but it was presented in a less-threatening way.

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After making a list of possible variables, students chose the first variable to test (in this case, mass). To scaffold instruction, I explicitly provided the procedure for testing the variable. When modifying a science fair project for ELLs, the teacher's greatest challenge is striking a balance between "teacher guidance and student initiative, with teachers making the decisions about how and when to foster student responsibility" (Fradd et al. 2001, p. 427).

Students followed my procedure and recorded their data in a table I created. Fradd and colleagues (2001) suggest that implementing a plan—not creating it—and reporting the results are the first responsibilities that students should assume.

When analyzing the data in Phase One, I encouraged students to use alternative ways to communicate their thinking when struggling to find the right words. Fradd and colleagues (2001) found that "providing ELLs with opportunities to communicate science through drawings, charts, tables, graphs, and computer-developed simulations reduced the language load required to participate" (p. 492). Specifically, ELLs shouldn't be required to use scientific vocabulary such as *independent variable* or *directly proportional* when first tackling a science fair project. Instead, students' natural vocabulary should be explained, negotiated (i.e., students and the teacher agree upon definitions of this vocabulary), and used by other students and the teacher. The science teacher shouldn't introduce scientific vocabulary until the class has established a common understanding through students' alternate explanations. This way, scientific vocabulary can be developed over time.

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Inquiry and the National Science Education Standards supports this approach: "Definitions based on direct experience more often result in understanding than just memorizing words" (NRC 2000, p. 133). Heeding these recommendations, my students and I made graphs of their data and analyzed the data in their natural languages. Using their established vocabulary, I provided frame sentences for students to use in their written analysis and conclusions. These frame sentences provide the standard, common words used in the sentences, leaving blanks for students to complete with words that apply to the specific analysis. Students wrote the entire sentence.

The next steps

In Phase Two, which took another week to complete, my students and I tested how the pendulum's angle (i.e., amplitude) affects its period, keeping the mass and all other variables constant. We began with a discussion of why it's important to test only one variable at a time. Even though we had already had this discussion several times earlier in the school year, it was still difficult for students to explain. Again, I initially encouraged them not to worry about using the right words. A few students effectively made their point using the pendulum as a visual aid.

When we began to test the angle, I provided the procedure, but students constructed their own data tables and graphs—with less help from me. They used the frame sentences from Phase One to guide the discussion and writing of their analyses. This sequence of transferring responsibilities to students is supported by Fradd and colleagues' (2001) recommendation that students independently analyze data and draw conclusions *after* implementing a plan and reporting the results.

In Phase Three, which took three to five days to complete, students tested length. Again, heeding Fradd and colleagues' (2001) recommendations, students planned the procedure themselves in addition to performing their

responsibilities from previous phases. At this point, clear leaders emerged from the group—providing much of the support I had provided in previous phases. Students still needed my support, but I was impressed with how much they had grown over the course of the project.

At no point did I require students to write out the procedure. Being familiar with their varying language skills, I suspected that such a task might be overwhelming and discourage them from focusing on the inquiry. Instead, I took pictures of students demonstrating each step and had them write captions for the pictures, providing any background information they requested. At the completion of Phase Three, students worked together to create a single poster board to display what they achieved.

Assessing understanding

As an informal summative assessment, I divided students into pairs, and they presented their findings to me—and to each other—by explaining various parts of the poster board. They were not allowed to read aloud from the poster board. Instead, they had to talk about what they did, what happened, and what they figured out, using their natural language and visual props when needed. To make the individual contributions less intimidating, students practiced in small groups before presenting to the class.

It was clear that some students were less comfortable presenting than others. Their presentation styles varied widely, as influenced by their native cultures. For example, some students had no issues with looking at me and other students while speaking, but others made no eye contact whatsoever. Well-intended teachers often dictate Western cultural expectations for student presentations, but since some of these students had never given a class presentation, I decided to focus on their content rather than their delivery. Needless to say, they (and I) were extremely proud of their accomplishments.

What the literature says

Fradd and colleagues (2001, p. 487) recommend that ELL teachers provide more overall structure to inquiry projects, "beginning with scaffolded explicit instruction and moving to student-initiated inquiry" over the course of the school year. Clearly, a science fair project can't be an ELL student's first introduction to inquiry. Previous inquiry activities must provide the scaffolding necessary for these students to engage in such extensive projects. The modifications teachers choose to make will depend on the areas of inquiry students have already mastered.

In community-centered environments, people are encouraged to learn from each other. Students are required "to articulate their ideas, challenge those of others, and negotiate deeper meaning along with other learners" (NRC 2000, p. 122). Especially in self-contained classes of limited English proficient students, learning communities can easily be built around common science fair projects.

In traditional projects, students work independently (or in small groups) on various investigations. For ELLs, it is wise to work in either larger or whole-class groups. Depending on the variety of languages in the classroom and students' proficiencies, they can be placed into groups with others who share their native language. If few students share a native language, or if all the speakers of a common language have little English proficiency, a whole-group project might be more advisable. In this way, students can work together to negotiate both the science and English skills needed to engage in inquiry.

Science for all

Including ELL students in science fairs and other extensive science inquiries creates an opportunity for them to participate in a learning community that acknowledges their unique needs; they are also able to engage in inquiry and acquire scientific and general English language skills without the initial pressure of the language requirements. Of course, successful implementation of such projects will present most teachers with a sizeable challenge but, considering the rewards that come with acceptance, the goal is most certainly worth the effort. ■

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